PRESERVING THE ARTIFACT: MINIMALLY INTRUSIVE CONSERVATION TREATMENT AT THE WINTERTHUR MUSEUM

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In the past, effecting repairs or replacements of broken or lost elements from wooden objects has presented the conservator with a number of problematic treatment alternatives. On the one hand, cutting or paring an uneven surface to produce a flat area for gluing on new material allows for proper adhesion but destroys original material. On the other hand, most attempts to fit new wood to an uneven surface do not achieve an intimacy of surfaces necessary for adequate adhesion. If strength requirements are minimal, even less than adequate adhesion may be enough. However, stresses associated with the use or even occasional moving of furniture usually raise the mechanical requirements of repair beyond what can be achieved by even fastidious fitting prior to adhesion. Restorers and conservators have occasionally resorted to the use of epoxy resin adhesives.

One method of compensation calls for replacement entirely with epoxy resin.[1] This can be accomplished in one of three ways. 1) A paste resin is built up on the surface and shaped to the desired conformation. 2) The shape is cast directly in place using either a fabricated mold (if the shape is geometric) or a mold taken from a similar and extant element. 3) An alternative to this method is to cast the new material to conform to the irregular surface but with a release membrane that allows the cured element to be removed for later readhesion. The common requirement of all three replacement techniques is that the interface between new and old material must be reversible, to which the epoxy adheres. In the case of the third alternative a reversible adhesive is used to affix the precast replacement element.

These methods work well when the object is painted or the surface coating is opaque for any reason. The epoxy can be colored and finished to match surrounding areas. However, when wood figure is visible, finish is thin or non-existent, or moldmaking is impractical, it may be desirable to make the replacement element out of wood. In this case a further development of the above technique is required. Here the wood replacement is fitted reasonably close to the irregular surface with particular attention to the fit at the visible surface, and adhered with a high viscosity, bulked or past epoxy resin in order to bridge any gaps at the interface. To provide reversibility a thermoplastic consolidant or primer is first used on the degraded surface. This “primer” should be chosen based on two characteristics: 1) the degree of heat and/or solvent reversibility and 2) the provision of an adequate surface for epoxy adhesion.

Winterthur furniture conservators have primarily been examining the properties of two consolidant/primers for use as barriers to in situ catalyzed epoxy adhesives. These are Butvar 98 (polyvinyl butyral) and hot animal hide glue (hereafter referred to as “glue”). While neither exhibits ideal properties for this technique, each has desirable qualities that may prove useful.

Butvar 98 (B-98) has been shown to be an excellent consolidant for degraded wood and has been used in this capacity in conjunction with cast replacement feet on a Windsor settee in the Winterthur collection. This object is subject to as much stress as any in the museum setting, and has shown no sign of failure after two years in service.

Ability for epoxy to wet and adhere to the B-98, and the actual as opposed to theoretical solvent reversibility of this resin are still areas in question. In service performance and limited bond strength testing tend to support positive claims for the epoxy-onto-B-98 adhesive bond. However, B-98 requires physical access for solvent reversibility which may require a great deal of mechanical removal, i.e, destruction, of the added element in order to be able to introduce the solvent to the interface. There are various ways to make better provision for this (see settee treatment) but nonetheless, it can be difficult.

On the other hand, glue, while problematic as a consolidant due to fast gelling, exhibits properties that could enhance reversibility. As a hygroscopic material, glue maintains an equilibrium moisture content (EMC) with the surrounding atmosphere. Applying heat will soften the adhesive enough to break the bond, but heat sufficient to the task would be detrimental to the object. However, it is possible to apply localized heat with a hand held microwave generator.[2] Known as a “wood-welder”, these units are used to catalyze adhesives with heat, but are equally useful for softening glues with a water component. Very short bursts of 10 seconds or less, depending on the thickness of wood, have been sufficient to soften glue in a joint without noticeably heating the surrounding wood.[3] This presents the possibility of easily removing added materials from a repair without having to provide physical access for a solvent.

As for the strength of the epoxy to glue adhesive bond, there is at least a possibility for covalent attraction. The past epoxy of choice at Winterthur is Araldite 1253.[4] The catalyst for this epoxy is a polyamine blend. When catalyzed in the presence of collagent, there is the theoretical possibility of covalent bonding with the primary and secondary amine groups.[5] This is an indication that glue would be an excellent primer/barrier if not consolidant. In practice the epoxy/glue bond does not exhibit the same strength as epoxy to B-98. Strength can be greatly enhanced, however, by roughing the surface of the glue before applying the epoxy. This may increase mechanical bonding or facilitate the chemical access to the amine groups on the collagen. Further research is warranted into both mechanical as well as chemical modification of the glue to maximize epoxy adhesion.

Preliminary analysis of various adhesive systems has been conducted with the assistance of Mr. Hugh Evans, Wood Technologist in the Applications Laboratory of Franklin Industries in Columbus, Ohio.[6]

Five adhesion systems were analyzed: Epoxy (no primer), glue bulked with sawdust/glue primer, Epoxy/glue primer, B-98 bulked with micro-balloons/B-98 primer, Epoxy/B-98 primer.

The epoxy was Araldite 1253. The glue was CM Bond granular hide glue purchased from Conservation Materials, Ltd., Sparks Nev. mixed in a ratio of 2 parts water by volume to 1 part glue by weight.. The Butvar B-98 was purchased from Conservation Materials Ltd. and used in a 20% solution in ethanol.

Blocks of black walnut, ¾″ X 1 ¾″ X 2″ were prepared with rough, irregular surfaces directly from the table saw. Pairs were oriented face to face with parallel grain direction and adhered with the systems described above. Clamping pressure was minimized to simulate the lack of interface intimacy expected in practice: pieces were merely rubbed lightly to produce a small squeeze out and held in place with spring clamps. Five samples of each combination were prepared and stressed to failure in sheer, parallel to the grain. Testing was done on an Instron Model 1125 Universal testing machine in the Applications laboratory in the Industrial Adhesives Division of Franklin Industries.

Average results for each sample group are as follows:

Adhesive	Primer	Stress failure in shear (Avg. psi)	Average percentage wood failure
Epoxy		2500	44%
Bulked glue	Glue	2397	68%
Epoxy	Glue	1890	76%
Bulked B-98	B-98	1693	40%
Epoxy	B-98	2427	98%

DISCUSSION

The results of this particular analysis seem to indicate that a system consisting of B-98 as a primer and epoxy as a gap filling adhesive would be the strongest while retaining an acceptable degree of reversibility.

Somewhat puzzling is the high strength of the unprimed epoxy joint which also exhibits a high degree of adhesive failure (relative to wood failure). This may be explained by the high degree of success exhibited by the B-98 primer/epoxy adhesive system. Perhaps the epoxy is better able to wet the surface in the latter case.

The surprising performance of the glue primer/bulked glue adhesive may be explained by the nature of the joint. Testing attempted to force the adhesive to bridge a gap by leaving the surfaces rough and by minimizing clamping pressure. Nonetheless, the planer nature of the surfaces to be joined, even with minimal pressure, may have not provided enough "gap" for useful analysis.

Although the performance of the glue primer/epoxy adhesive system was disappointing, it is within an acceptable range for a number of reasons. Often it is preferable that the adhesive fails before the substrate. Also, although ongoing testing is incomplete, empirical observation has noted that roughing or otherwise mechanically (or chemically?) modifying the glue primed surface greatly enhances strength characteristics. Finally, the previously mentioned possibility of microwave reversibility makes further analysis and or modifications of this system very intriguing.

Further analysis will include that already mentioned as well as different orientation between wood samples, e.g., end grain to side grain; a more controlled and variable gap for the adhesive to bridge; heavier B-98 primer; a range of epoxy formulations; joining and testing of degraded wood that has been consolidated with the chosen primer.

CASE STUDY

As an example of the use of the B-98/Araldite 1253 system, treatment of a 17th century Massachusetts joined chest (WM acc. #58.543) is presented.

One end panel assembly was seriously degraded from insect attack and rot. Both lower leg portions had been poorly replaced, and many of the tenons in the assembly had been crudely and inadequately replaced. Much deteriorated wood had been lost in the areas of joints.

The end panel was disassembled from the body of the chest by removing tenon pins and withdrawing what remained of the tenons. The end panel was then disassembled and replacement wood removed. Degraded wood was then consolidated with a 20% solution of B-98 in ethanol. This was accomplished with repeated brush coats as well as a long term drip application to seriously degraded areas. After substantial consolidation, the pieces were allowed to thoroughly dry. It was noted at this time that all degraded surfaces exhibited a film of consolidant.

Replacement wood was shaped and closely fitted to the degraded areas of loss and adhered with Araldite 1253 epoxy.

New wood serving as replacement tenons was trimmed and fitted to existing mortices at this time.

Coloring and toning of new material was executed with Magna colors, dry pigments and garnet shellac. The object was reassembled with all extant original material and final color integration was completed.

NOTES

1. Michael S. Podmaniczky. "Conservation of a Degraded Late 18th Century Windsor Settee", *WAG Preprints* 1988-New Orleans.

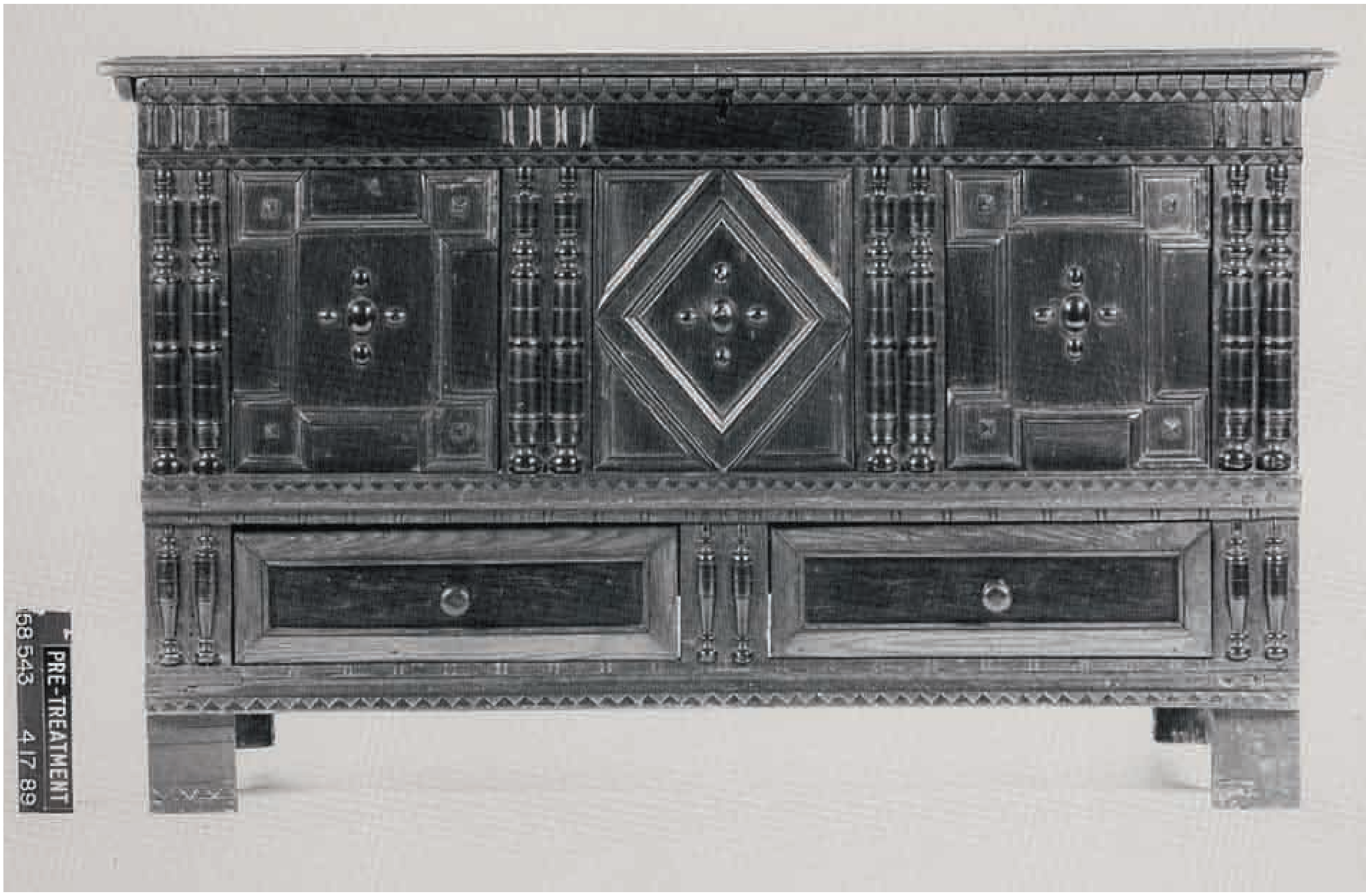
2. Workrite Products Co., 1315 S. Flower St., Burbank, Calf. 91502

3. For assistance with this machine thanks are due to Jim Adajian of Adajian and Nelson, Inc. Baltimore, Md., restorers and makers of fine furniture.

4. Formulated Systems Group, East Lansing, MI, Division of Ciba Geigy Corp.

5. Personal communication with Pat Hardy, Ciba Geigy, 3160 Research Park Drive, Madison Heights, Mich. 48071. See also: John S. Mills and Raymond White, *The Organic Chemistry of Museum Objects* (Boston, Mass.: Butterworths, 1987), pp. 74 & 116.

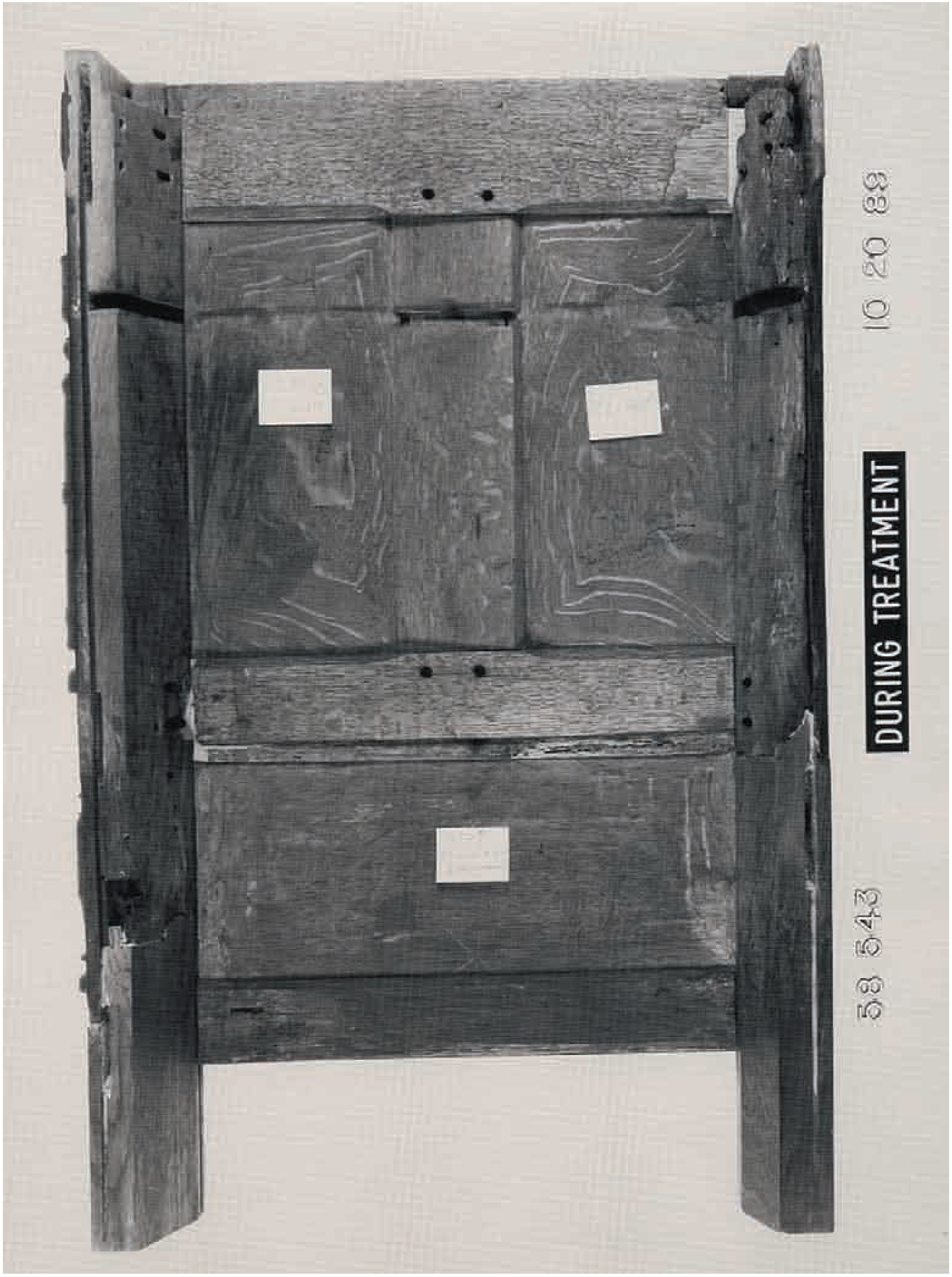
6. I wish to acknowledge the advice and assistance in sample preparation and testing given by Susan Buck, second year Fellow in the Winterthur Art Conservation Program.



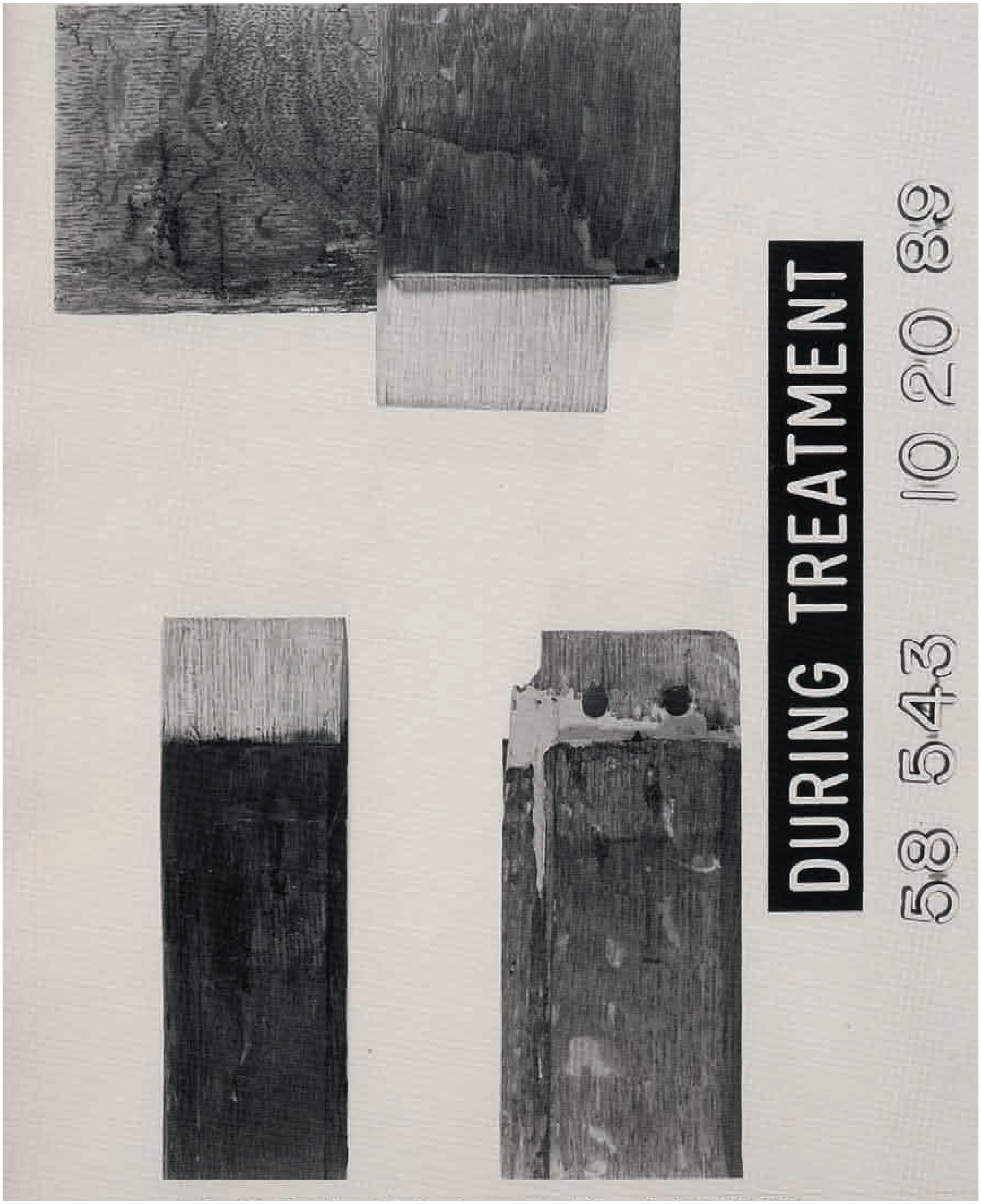
#1. WM #58.543. Before treatment.
(Photo courtesy of The Henry Francis du Pont Winterthur Museum.

#2. WM #58.543. End Panel disassembled. Before treatment.
(Photo courtesy of The Henry Francis du Pont Winterthur Museum.)

#3 WM #58.543 End panel disassembled. During treatment.
(Photo courtesy ot The Henry Francis du Pont Winterthur Museum.)



#4. WM #58.543. End panel reassembled. During treatment.
(Photo courtesy ot The Henry Francis du Pont Winterthur Museum.

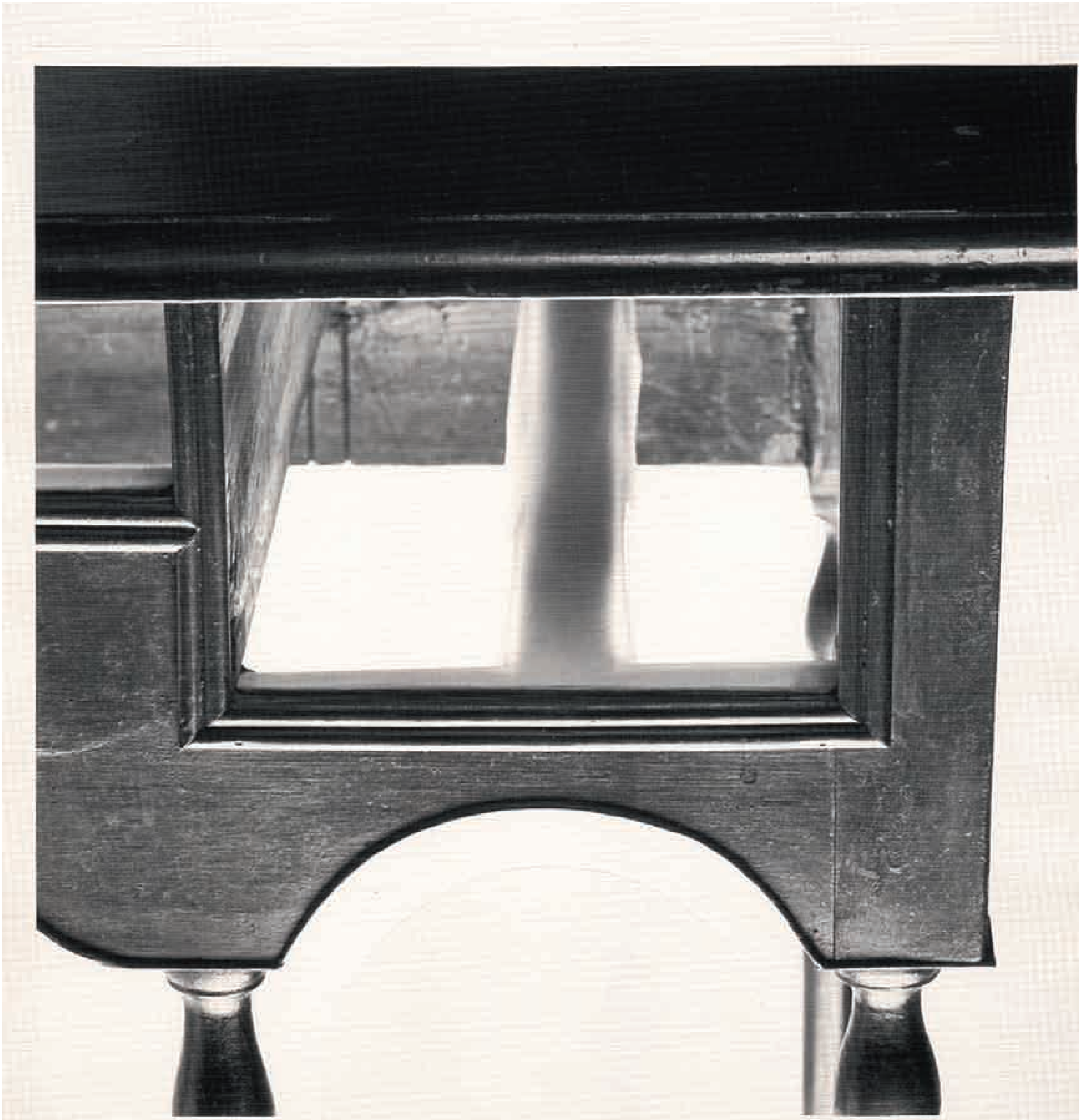


#5. WM #58.543. Detail of reconstruction. During treatment.
(Photo courtesy of The Henry Francis du Pont Winterthur Museum.)

ADDITIONAL TREATMENTS

The desire to preserve original material and evidence of workmanship and age has spawned a variety of treatment techniques now used by the furniture conservation group at Winterthur. The pictured treatments represent work, in varying degrees, by Mark Anderson, Henry Cromwell, Gregory Landry and Michael Podmaniczky.

An extension of rebuilding a void using a synthetic fill material is overlaying a thin wood membrane on top of a bedding compound. Here a microthin shaving of oak from the smoothing plane was pressed onto wet Araldite 1253 using a Plexiglas caul. Timber selection and grain orientation were selected for the best possible match. (Photo courtesy of The Henry Francis du Pont Winterthur Museum.)



The problem of rebuilding worn drawer runners is often solved by cutting, padding or patching. An effective and time saving method which is completely non-intrusive is to fit 0.030” high density polyethylene plastic to the runner or the guide. It is easily scored and bent to form overlays or attached with hot melt adhesive to an isolated substrate.

(Photo courtesy of The Henry Francis du Pont Winterthur Museum.)

Replication of missing design elements does not necessarily fall into the realm of non-intrusive conservation. In some cases excessive modification of fragmentary elements or conjectural recreation can be avoided if entirely new faux grained castings are substituted for the original. Here a reproduction element is cast onto a core of mahogany and colored to match the original. The process utilized silicone rubber mold compound, epoxy casting resin, and a combination of natural and synthetic dyes and resins.

(Photo courtesy of The Henry Francis du Pont Winterthur Museum.)